OMNIMON! (TM)
USER'S GUIDE

by

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SYSTEM REQUIREMENTS: ATARI 800/400 Home Computer

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AUTHOR'S EARNEST ENTREATY

I have done my best to offer here a quality program at a reasonable price. This is my livelihood. Please do not make copies of this program for any reason other than personal backup. Thank you.

INTRODUCTION

Greetings fellow ATARI Home Computer owner. I am sure you are just as proud of your system as I am of mine and enjoy buying accessories to extend its power and convenience. From that point of view, OMNIMON! is one of the most powerful additions you can make to your computer. Any serious ATARI owner will find it indispensable after using it for the first time.

OMNIMON! is a resident machine language monitor which, once installed, is always available to you. What that means is that you never have to load it and you can call it up no matter what program happens to be running at the time. Once running, OMNIMON! gives you complete control over your computer. This includes the ability to easily examine and modify memory or the 6502's registers, to dump data to a printer, and to read and write to the disk drive(s) without DOS. It also has a complete set of debugging tools including a disassembler, single step, and a unique JSR function for testing out subroutines. And all of these features are available to you at any time, no matter what program is running, simply by pressing SYSTEM RESET along with either the OPTION or SELECT button!

If you have been wanting to learn assembly language programming, OMNIMON! can make it a very pleasant experience. Since it is ROM resident, you can always get back to OMNIMON! even if your program hangs up in an infinite loop. (See the description of OMNIMONA, the advanced version of the monitor, for a method of recovery if the system is locked up.) You can even call OMNIMON! at critical points in your program to examine things before continuing execution. OMNIMON! is extremely user friendly so even programmers with little experience should find it very easy to use.

GETTING STARTED

After installing OMNIMON! in your computer (if you have not done so, see OMNIMON! INSTALLATION INSTRUCTIONS), you should be able to powerup your computer as usual. To enter the OMNIMON! program, hold down the OPTION key and press SYSTEM RESET. This method of entering OMNIMON! will cause a warmstart up to the point that the application program would normally be given control. Instead OMNIMON! takes control and you should see the OMNIMON! header written across the top of the screen indicating that the program is running:

```
      David Young OMNIMON! Copyright 1983

         PC NV-BDIZC ACCUM X-REG Y-REG STACK
       Axxxx   xx      xx    xx    xx    xxx
```

When you are ready to exit OMNIMON!, hold down the START button and type RETURN. This will cause the warmstart to go to completion, giving control back to the application program. Notice that pressing SYSTEM RESET by itself will cause a normal warmstart. Later we will discuss another method of entering OMNIMON! which preserves the PC and CPU registers of the interrupted program.

Once you have OMNIMON! running, the first command to learn is the 'HELP' command. As is fairly standard practice in user friendly software, OMNIMON! uses '?' (RETURN) to give you a list of all the commands available. So type '?' followed by RETURN and you will see the following:

```
CPU/CHG:C
DPY/CHG:D (adr adr)
EXECUTE:E (byt)
JSR    :J adr
LINK DR:L (drive#)
PRINTER:P
RD DISK:R (sec# adr #)
SEARCH :S adr byt byt ...
TOGGLE :T
WR DISK:W (sec# adr #)
DIS/CHG:X (adr adr)
PSH STK:+ byt byt ...
POP STK:-
```

The HELP command not only provides a list of commands but also indicates the parameters each command expects. Parameters in parentheses are optional. If they are omitted, OMNIMON! will try to interpret the command in a manner convenient to you. Usually this means executing the command on the next logical memory location or sector. If you are anxious to start using OMNIMON!, you can do so immediately with just this little bit of knowledge. With a little experimentation you should have little trouble figuring out what most of the commands do. When you are ready to learn some of the more subtle features built into OMNIMON!, read the rest of this documentation.

There are a few important things to point out before proceeding:

1) All numerical input and output is done in hex.

2) Parameters are delimited by a space or other non-hex character.

3) The command being processed will be aborted if an illegal parameter is encountered or if a necessary parameter is not supplied.

4) It is not necessary to retype a command if it is already present on the screen. Just position the cursor on the same line, make changes if you wish, and type RETURN. All the normal ATARI editing commands are available.

5) The processing of most commands can be stopped by holding down the START button. This allows you to terminate a long listing, search or single step. Use CTRL-1 to temporarily halt and restart a listing.

DISPLAY MEMORY: D (start addr) (end addr)

This command is used to view data in memory in either hex or character format, depending on the current data format (see TOGGLE). In hex format the data is output to the screen as 1 or more lines of 8 hex bytes separated by spaces. In character format the data is output as 1 or more lines of 24 byte character strings. On each line, the address of the first byte precedes the data.

In either data format the letter 'A' is appended to the start of each line. This in fact represents the ALTER MEMORY command (see the following command description). The effect is that, once you have used 'D' to display part of memory, you can alter any byte(s) by simply positioning the cursor, typing the change(s), and hitting RETURN. You must type RETURN on each line that you alter for the change to take effect. Also, the current data format must match the way the data was represented on the line. One other limitation in the character mode is that a line containing the character representing $9B is not alterable past that character. The OS cannot handle a record with an imbedded $9B. If you wish to alter a line after a $9B character, redisplay the line starting just past it.

To display memory, type 'D' followed by optional start and stop addresses and then RETURN. You can display up to 32K bytes ($8000) with one command. If you omit the stop address, only a single line of data will be printed. If you omit the start address, the next logical line of data will be printed (either the next 8 or 24 bytes of memory, depending on the data format). One last convenience is that once you have used the 'D' command, OMNIMON! will default to that command if you just type RETURN. This allows you to scroll through memory by holding down the RETURN key. This default will remain in effect until one of the other 'persistent' commands (R or X) are used, at which time they will become the default.

TOGGLE DATA FORMAT: T

As mentioned previously, all numerical data is represented in hex. However, when dealing with ASCII text it is more convenient to work in character format. The TOGGLE command (T) is used to switch between hex and character format. It affects three commands: ALTER MEMORY (A), DISPLAY MEMORY (D) and SEARCH MEMORY (S). Other commands are unaffected by the current data format.

To switch data formats type 'T' (RETURN). Upon first entering OMNIMON! the data type defaults to hex.

ALTER MEMORY: A addr byte byte ...

This command is used to change 1 or more contiguous bytes of memory. You can type the change either as hex bytes (separated by spaces) or as ATASCII character strings, depending on the current data format (see TOGGLE). While it is possible to use the 'A' command by itself at any time, it is not recommended. To display the area of memory first with the 'D' command and then to position the cursor and make the change is much safer (see DISPLAY MEMORY). This way you not only verify that the memory at that location is the memory you intended to change, but also that the current data format is compatible with the data you are typing.

To use the ALTER MEMORY command, type 'A' followed by an address. Use a space to separate the address and the data and then start typing the data. If in hex format, type hex bytes delimited by spaces. If in character format, type a continuous character string. Terminate the command with RETURN. At that point the indicated changes will be made. The command line can be as long as you like or until the computer squawks. SQUAWK!

SEARCH MEMORY: S addr byte byte ...

Searching is something that computers do very well and OMNIMON! has a very nice search function that works in either hex or character mode. It will scan memory for any sequence you specify and display it in a manner similar to the DISPLAY MEMORY command every time it is found. This means you can alter any occurrence of that sequence by simply positioning the cursor, typing the change and hitting RETURN (see DISPLAY MEMORY).

To use the SEARCH MEMORY command, type 'S' followed by the address where you would like the search to begin. Then type a space followed by the search sequence. This will be hex bytes separated by spaces in hex mode or a character string in character mode (see TOGGLE). The search will begin when you hit RETURN. The search sequence can be any length up to the limit of the ATARI terminal input buffer. Even though it only takes a few seconds to search all of memory, a search can be aborted by holding down the START button.

PRINTER ON/OFF: P

If you want a hardcopy record of your OMNIMON! session, you can use the 'P' command to cause anything being output to the screen to be echoed to the printer. In character mode, inverse video characters are printed as normal video and unprintable characters are translated to dashes (-). Otherwise, everything on the screen will show up on the printer. There is even a special single step mode (see EXECUTE) that will trace through a program while outputting only to the printer and not to the screen. This is useful for programs that use the screen in modes other than GRAPHICS 0.

The 'P' command is a toggle function. Typing it once will enable output to the printer and typing it again will disable output. If the printer is not turned on or selected, the message 'I/O ERROR' will result. Care should taken if the printer is enabled while reading or writing to the disk (see READ DISK or WRITE TO DISK).

DISK INPUT/OUTPUT

Anyone who owns my disk utility DISKSCAN knows how useful it is to be able to edit raw sector data on a disk. One of my goals in designing OMNIMON! was to incorporate some of the features of DISKSCAN. Imagine, a resident mini-DISKSCAN!

Well, the end result has far exceeded my expectations. With OMNIMON! you can not only read and write individual sectors, but multiple sectors to and from anywhere in memory. And it not only works in sequential mode, but it can also follow sector links. In fact, you can read in an entire DOS file from a disk without even booting up DOS! And the frosting on the cake is that OMNIMON! works equally well in single or double density, a dream come true for the growing number of double density drive owners.

LINK/SEQ MODE & DRIVE #: L (drive#)

When you first enter OMNIMON!, the program assumes that you wish to talk to drive #1 and that the sector mode is sequential. If you wish to address other drives or follow sector links, use the LINK command to put OMNIMON! in the correct mode. The LINK command is actually two commands in one. When used by itself (without a parameter) 'L' means to toggle from sequential to linked mode or vice versa. When followed by a drive # (1-4), 'L' means to switch the drive ID to the specified drive. From that point on, all disk I/O will be directed to that drive.

To toggle between the sequential and linked sector modes, type 'L (RETURN)'.To direct disk I/O to a different drive, type 'L' followed by the drive # and RETURN.

READ DISK: R (sector#) (buffer addr) (# sectors)

The READ DISK command is one of the most powerful, user friendly functions of OMNIMON!. It can be used to read one or more sectors, either sequentially or linked, from any disk drive, single or double density. We will start out by using the READ DISK command to read one sector at a time. You will find it behaves somewhat differently when operating on more than one sector at a time.

To read a single sector into memory type 'R' followed by the sector # and RETURN. OMNIMON! will assume a buffer address of $6000 unless you specify something different after the sector #. From that point on OMNIMON! will assume that new buffer address for subsequent disk I/O. Once you have the sector in memory you can operate on it with any of the other OMNIMON! commands including DISPLAY, ALTER, SEARCH, DISASSEMBLE, etc. One convenient feature is that, after a READ DISK command, OMNIMON! will assume the buffer address if you use 'D' or 'X' without a start address. (Try typing 'D (RETURN)' after reading a sector into memory).

Now, if you wish to read the sector which logically follows the last sector read into memory, type 'R (RETURN)'. In sequential mode, the next physical sector on the disk will be read. In linked mode, OMNIMON! will reference the sector link of the current sector to determine the next sector to read. In either case, the new sector will be read into memory at the SAME buffer address, overlaying the old sector.

NOTE: IF THE PRINTER IS ENABLED WHILE READING SINGLE SECTORS, THE SECTOR # AND BUFFER ADDRESS MUST BE SPECIFIED EACH TIME. This is because the printer and disk share the SIO DCB (Device Control Block).

Ready for a couple more examples of user friendliness? One is that the 'R' command, like 'D' and 'X', is a 'persistent' command. That means that once you use the 'R' command, OMNIMON! will default to that command if you just type RETURN. This default will remain in effect until one of the other persistent commands are used. What this means is that you can read through an entire file (or disk, if in sequential mode) by reading the first sector and then simply holding down the RETURN key. One other convenience is that OMNIMON! will not read past the end of file if it is in linked mode. Thus, if you were reading through a file as suggested above, simply hold down the RETURN key until 'EOF' is printed. At that point, the last sector of the file is at the buffer address. You are free to add something to the end of the file (perhaps an autorun vector) and then to write the sector back out with the WRITE SECTOR command.

Reading multiple sectors is somewhat different from reading single sectors. For one thing, the sector #, buffer address, and sector count must be specified each time. The other difference is that, instead of consecutive sectors overlaying each other, the buffer address is incremented between sectors so that the disk data fills memory. The exact amount by which the buffer address is incremented depends on the sector mode and the density of the drive. The effect is that in sequential mode all bytes of the sector are preserved, while in linked mode the sector links are overlayed. This is a desirable feature if you want to read an entire DOS file into memory. If you find this discussion confusing, it is recommended that you read my tutorial on ATARI DISK DATA STRUCTURES in the DISKSCAN USER'S GUIDE or the MARCH 1982 issue of COMPUTE! magazine.

An example may be of help. First, put OMNIMON! in character mode with 'T' and sequential mode with 'L'. Now type 'R 169 6000 8'. This will read in the 8 sectors of the directory into the buffer at $6000. Now type 'D' followed by several RETURNs. You will be able to read the names of the files on the disk. Choose the filename of a short file, put OMNIMON! in hex mode with 'T', and use 'D addr' to display the 5 bytes just prior to the filename. The first byte is the status while the next two are the size of the file and the next two are the start sector. Now put the program in linked mode with 'L'. Read in the entire file with 'R (start sector) 6000 (file size)'. Type 'D' and hold down the RETURN key to scroll through the data of the file.

If the file happens to be a BINARY LOAD file, a slight variation of this technique is recommended. Instead of specifying an arbitrary buffer address of $6000, look at the first sector of the file to determine the load address. Then subtract 6 bytes to account for the load vector and use that number as the buffer address. Then, after the file is loaded, it can be executed, searched, disassembled or otherwise manipulated to your hearts content. Notice that the entire program will be loaded to the correct place in memory only if there is but one load vector at the beginning of the file. OMNIMON! as a rule ignores load vectors. If you must load a file with multiple load vectors, use DOS.

Once you have a binary load file in memory you can create a boot disk by switching over to sequential mode and writing the program back out to a disk starting at sector 1. You will need to leave 6 overhead bytes at the beginning of the first sector. See the ATARI OPERATING SYSTEM USER'S MANUAL for details on the boot process. The converse of this process would be to create a binary load file from a boot record. This can be done by first booting up DOS, going to OMNIMON!, and reading in the boot record in sequential mode to a convenient place in memory. Then you would exit back to DOS and do a BINARY SAVE on that portion of memory. Then you may have to use OMNIMON! to change the load vector at the beginning of the file to make it load in at the correct place. In fact, you may have to use OMNIMON! to load the file if it loads on top of DOS. The same technique can be used to make a binary load file out of a cartridge but you will have to append a few load vectors to get the program going. For example, the following 3 load vectors should be appended to the end of BASIC: 6A 00 6A 00 90 E2 02 E3 02 F6 F3 E0 02 E1 02 00 A0.

One final convenience is that each time a single sector is read, its # is printed along with the buffer address. This also occurs when multiple sectors are read, but only when the printer is on. Thus, if you read in an entire file with the printer on, you get a sector map of that file. Now if, while inspecting the file in memory, you find that you wish to make a change to the file on disk, you can compare the buffer address to the sector map of the file to determine the sector where that piece of data resides. Then you can use 'R sec#' to fetch that sector, make the change, and use 'W sec#' to store the sector back on disk.

WRITE TO DISK: W (sector #) (buffer addr) (# sectors)

The WRITE TO DISK command allows you to write one or more sectors worth of memory out to disk. The one big difference between it and the READ DISK command is that it only works in the sequential mode. That means that it will not create a DOS file, i.e., it will create neither a directory entry nor sector links. If you do wish to create a DOS file out of memory it is best to use the BINARY SAVE option of DOS. However, it is not always possible to get DOS into memory without losing your data. In this case, OMNIMON! may be the only way save your data. If you do wish to create a DOS file out of the memory you have written to disk with OMNIMON!, use the technique described in the last section. You could also use the BINARY LOAD FILE function of DISKSCAN in the sequential mode which will pick up sectors and redeposit them as a DOS file.

IMPORTANT: Use a scratch disk when writing multiple sectors worth of memory to disk with OMNIMON!. The program pays no attention to data already on the disk and may overlay it.

The primary purpose of the WRITE TO DISK command is to support the modification of one sector at a time. A typical scenario is as follows:

> Turn the printer on, read a file into memory as described in READ DISK, and turn the printer off. Search the file to find the data to be changed. Compare the address of the data in memory to the sector map created while the file was being read in. Read that particular sector into memory with 'R sec#'. This insures that you not only have the data of the sector but also the sector link. Then alter the sector and write it back out with 'W sec#'.

Another application for the WRITE TO DISK command would be to move a block of memory from one location to another. This is accomplished by writing the data out from one buffer address and reading it back in at another. It is important to use a scratch disk for this operation or at least be very careful that you are writing to an unused portion of a disk.

Be careful when omitting the sector # because the default has already been incremented in anticipation of the next READ DISK. In fact, the only safe time to omit the sector # is when that sector is the last one of a linked file.

SEVERAL WAYS TO ENTER OMNIMON!

We have seen how to enter OMNIMON! by holding down OPTION and pressing SYSTEM RESET. This causes a normal warmstart followed by a jump subroutine (JSR) to OMNIMON!. When you exit OMNIMON! after entering it in this way (by holding down START and pressing RETURN), the warmstart goes to completion in a normal fashion. This is fine for some applications but there is another way to enter OMNIMON! which disturbs the program running as little as possible.

When you hold down SELECT and press SYSTEM RESET, the program running at the time is interrupted. However, instead of doing the entire warmstart, parts of it are skipped over so as to preserve the state of the system as much as possible. Specifically, the OS variables and the stack are left undisturbed. Usually this allows you to reenter the program by simply exiting OMNIMON! in the normal fashion. For instance, you can pop into OMNIMON! from either DOS or BASIC, execute some OMNIMON! commands, and pop back into the interrupted program almost as if you had never left it. I say 'almost' because the OS is likely to return a bogus value if it was waiting for a keystroke when it was interrupted. For that reason it is best to hit BREAK upon return to the program. Of course, if the program makes use of any graphics other than MODE 0, it is unlikely that you will be able to successfully reenter the program without restarting it. This is also true of programs which alter the interrupt RAM vectors ($200-$224) because OMNIMON! restores them to their original values.

There are a couple of small problems with using SELECT/RESET (instead of OPTION/RESET) to interrupt DOS or BASIC. OMNIMON! makes use of the SIO interrupt routines in the OS ROM by altering the interrupt vectors at $20A-$20D. This is so the printer and disk interface of OMNIMON! will work even if DOS is not in memory. Now if you return back to DOS with START/RETURN these interrupt vectors will remain in effect. But DOS hangs up occasionally unless it is using its own special SIO handlers. If you wish DOS to restore its special vectors, exit OMNIMON! with SYSTEM RESET. Another problem with SELECT/RESET is that MEMLO ($2E7) gets restored to $700 so that the FMS or any other program in low memory is unprotected. For that reason it is best to exit OMNIMON! back to BASIC with RESET. Alternatively, always use OPTION/RESET to enter OMNIMON! from BASIC.

Another way to enter OMNIMON! is particularly useful for debugging assembly language programs. This is accomplished by putting 'JSR $C001' at critical points within the program. At each of these points OMNIMON! will be entered and you will have all of its facilities available for examining the intermediate results of your program. When you are ready to continue executing your program, just exit OMNIMON! with START/RETURN. There are some restrictions on this technique however, specifically special graphics and time critical I/O.

Yet another way to enter OMNIMON! is from BASIC with a 'X=USR(49152)'. In fact, this is the recommended way to enter the monitor if you have not modified the interrupt vectors at $FFFA-$FFFD as described in the OMNIMON! INSTALLATION INSTRUCTIONS. You can exit back to BASIC in the usual manner (START/RETURN).

It should also be pointed out that OMNIMON! will be entered automatically if a 6502 BRK instruction (0) is ever executed. Thus, you can set a breakpoint anywhere in your program by storing a 0. When you pop into OMNIMON! after executing a BRK instruction, you should restore the original instruction and subtract 2 from the PC. Now you can continue executing your code when you exit OMNIMON!.

CPU REGISTERS: C

You will notice that, upon entering OMNIMON!, the 6502's internal registers are printed out with the following heading:

```
PC NV-BDIZC ACCUM X-REG Y-REG STACK
```

The meanings of these headings are self-explanatory except for 'NV-BDIZC'. These are the individual bits of the status register spelled out. Thus, this is a snapshot of the state of the CPU just prior to entering OMNIMON!. The PC (program counter) is pointing to the next instruction to be executed. The program will continue executing at this point when you leave OMNIMON! with START/RETURN.

The CPU state can be examined at any time with the CPU REGISTERS command 'C'. In addition, the CPU state can be changed by simply positioning the cursor over the value, typing the change, and hitting RETURN. The new values for the registers will be in effect when you leave OMNIMON! to resume execution of the suspended program. The only CPU register that cannot be changed directly is the stack pointer. This can be changed only by the PUSH STACK (+) and POP STACK (-) commands.

One application for the 'C' command is to GOTO anyplace in memory. This is accomplished by altering the PC to point to the address where you wish execution to resume when you press START/RETURN. Typically this might be back to DOS, whose address can usually be found by looking in location $000A (DOSVEC).

Another area of interest is the stack. Remember, the stack pointer always points to the next FREE entry. All the values between the stack pointer and $1FF are typically return addresses of nested subroutine calls. This, in fact, is a vertical cross section of the execution history of the program. This is extremely useful for finding your way around in a program you wish to modify in some way. If you wish to to locate the part of a program which is performing a certain function, just start the program executing that function and press SELECT/RESET. Because the stack is preserved with this method of entering OMNIMON!, you can tell where the program is and where it has been by noting the PC and the return addresses on the stack. Another way of locating a certain piece of code is to search ('S') for a particular address it might reference.

PUSH STACK: + byte byte ...

The PUSH STACK command is for adding bytes to the stack and thereby increasing the stack pointer (which grows downward in the 6502). These bytes will be available to the code pointed to by the PC when OMNIMON! is exited. Notice that the first byte after '+' is the first one to be pushed onto the stack.

Please note that the stack pointer displayed with the 'C' command is not the ACTUAL stack pointer while OMNIMON! is running. OMNIMON! uses the stack for its own purposes and is actually nested somewhat deeper. It is not wise to make changes directly to the stack unless you use PUSH STACK or POP STACK. Even then you must be careful not to cause the stack to overflow or underflow.

POP STACK: -

The POP STACK command takes bytes off of the stack one at a time and decreases the stack pointer (which actually increases in value). Be careful to not cause the stack to underflow.

DISASSEMBLE MEMORY: X (start addr) (stop addr)

Just as it is possible to display memory in hex or character format, it is also possible to translate 6502 machine code to assembly language. OMNIMON! does this in a handy fashion by printing out the object code along with the instruction. Once again, it is possible to change the object code (to the left of '*') by positioning the cursor, typing the change, and hitting RETURN. Another convenience is that the value at the address specified with indirect addressing modes (without regard to the index register) is printed in parentheses.

Just like the 'R' and 'D' commands, 'X' is 'persistent'. Once you have disassembled one or more instructions, you can continue disassembling simply by holding down RETURN. This will remain in effect until 'R' or 'D' are used. The disassembler can be aborted at any time by pressing the START button.

EXECUTE MEMORY: E (option/# steps)

The EXECUTE MEMORY command is actually a single step command in disguise ('S' is used for SEARCH). This command causes the instruction pointed to by the PC to be executed. Then the registers are printed out along with the NEXT instruction to be executed. If the step count was 1 (or not specified) then execution will stop. Otherwise it will continue single stepping through the code for the specified # steps. The maximum number of steps at one time is 31 for reasons soon to become clear.

While the low order 5 bits of the optional parameter are a step count, the high order 3 bits have special meaning. The MSB means 'step forever'. Thus, 'E 80' means 'step forever and print the trace to the screen'. Notice that the trace will also be echoed to the printer if it is enabled. Stepping can be aborted by pressing START.

Bit 6 of the parameter means 'don't print the trace to the screen'. However, the trace will still be output to the printer if it is enabled. Thus, 'E C0' would step forever without printing the trace to the screen. In combination with the printer this is useful for stepping through programs which use special graphics modes.

Bit 5 of the parameter means 'sample the results of every 32 instructions'. Thus, 'E E0' would step forever without printing to the screen and the trace would be output to the printer every 32nd instruction (if it is enabled). This is kind of a weird mode, but somebody may find a use for it someday.

One other nice feature of the 'E' command is that it will treat a call to the OS as a single instruction instead of stepping through all the code in the OS. OMNIMON! does this by temporarily giving up control of the CPU but intercepting it on the return from the OS. However, you should avoid stepping through CIO calls to the screen editor (E:) unless printing to the screen is disabled with bit 6. OMNIMON! considers any address above $C000 to be OS.

We have seen that the EXECUTE MEMORY command is very powerful and flexible. One restriction, however, is that it will not step through a 'SEI' instruction. If you are stepping through a program and encounter a SEI, disassemble on past it to find the 'CLI'. Just past the CLI put a temporary BRK instruction (0). Now step through the SEI. OMNIMON! will temporarily lose control of the program but will regain it when the BRK instruction is executed. Now restore the original value to the location where the BRK was set. After subtracting 2 from the PC you are ready to continue stepping.

JSR: J addr

The JSR command is a very powerful feature for executing a subroutine and returning control back to OMNIMON!. It can be used for testing out subroutines during the development of an assembly language program. With some care it can also be used to call the OS to, say, format a disk.

When you execute the 'J' command you will notice that the registers are printed out but that the subroutine is not yet executed. In fact, the 'J' command does nothing more than change the PC to the specified address and push the address of OMNIMON! on the stack to act as the return address for the subroutine. Now you are free to set up for the subroutine call by altering the registers or memory if necessary. When you are ready to actually execute the subroutine press START/RETURN. Upon return you will notice that the PC is restored to its original value but that the other registers reflect the results of the subroutine.

As an example, put a fresh disk (or one you don't mind formatting) in drive 1. With the printer disabled, store a 1 in $301, a $21 in $302, and a $80 in $303. Now execute a 'J E453' and press START/RETURN. The disk in drive 1 will be formatted and then control will be returned to OMNIMON!.

Sometimes after interrupting a program with OMNIMON!, you will not be able to restart it without reinitializing it. The start and initialization addresses for a program are typically at $000A and $000C respectively. Since a proper initialization routine is always a subroutine, you can use 'J (init addr)' to initialize the program. When control returns to OMNIMON!, you need only change the PC to the start address and exit OMNIMON! with START/RETURN to restart the program.

QUESTIONS?

I welcome comments, suggestions and dealer inquiries:

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LIMITED WARRANTY

For a period of one year following the date of purchase CDY CONSULTING will repair or replace any OMNIMON! unit proven to be defective. Please return the defective unit to the place of purchase.

Binary Load Files

This is one area that most people are a little fuzzy on. It's not surprising really, since there does not appear to be any definitive documentation on it anywhere! An exhaustive presentation will be made here even though it will be quite short.

Definition: **load vector** - from 4 to 6 bytes consisting of 2 optional bytes of FF FF, a 2 byte start address, and a 2 byte end address (in that order).

Example: FF FF 00 06 02 06 - The first 2 bytes are optional and ignored during the load process. The second 2 bytes are a start address of $600 and the last 2 bytes are an end address of $602.

The only time that the first 2 bytes of FF FF are required is at the beginning of a binary load file. If those bytes are not there, DOS will refuse to perform the binary load. (The 'G' command of OMNIMONL will, however, load it gladly.) The rest of the time the first 2 bytes of FF FF, if they exist, are ignored. The only time that these 2 optional bytes should occur anywhere else but at the beginning of a file is if 2 binary load files were appended together.

What does a load vector do? It tells DOS (or the 'G' command of OMNIMON) where in memory to put the 1 or more bytes which follow in the file. How many bytes is determined by subtracting the start address from the end address and adding 1. In the example above, 3 bytes would be read from the file and put in locations $600 to $602.

What happens when enough bytes have been read in to satisfy a load vector? These things will happen in this order:

1) Locations $2E2 and $2E3 will be examined. If they are both zero, goto step 2. If they are nonzero, a JSR will be made to the address contained in these locations. Upon return, zero $2E2 and $2E3 and fall into step 2.
2) If the end of file is not reached (i.e., there are more bytes in the file), another load vector is assumed to immediately follow and will be processed as previously described.
3) If the end of file (EOF) is reached, examine locations $2E0 and $2E1. If they are zero, terminate the binary load. If they are nonzero, do a JSR to the address in these locations. Upon return, terminate the load.

Still confused? Let me try to simplify. If you see a load vector like 'E2 02 E3 02', you know that the subroutine at the address specified in the following 2 bytes will get executed immediately, prior to continuing the load process. If you see a load vector like 'E0 02 E1 02', you know that the subroutine at the address in the following to 2 bytes will be executed after the end of file is reached.

Now that you understand everything there is to know about binary load files, let's take a typical example: converting the BASIC cartridge to binary load file. I use this example because it is instructive and, because of the lack of copyright notice, appears to be legal. Using this technique on other cartridges could be illegal and may not work anyway due to the booby traps designed to prevent them from running out of RAM.

Whenever attempting something new, it is advisable to try it out manually from OMNIMON first whenever possible. Let's see what it takes to get the BASIC program to run out of RAM:

- Turn on the computer with BASIC installed and pop into OMNIMON.
- Insert a formatted scratch disk into the drive and execute the following command: 'W1 A000 40 (RETURN)'.
- Remove the BASIC cartridge, boot up DOS and pop into OMNIMON.
- Because OMNIMON restores MEMLO to $700, we should reinitialize DOS by doing a JSR to the address at DOSINI ($C,D). For 2.0S that would be 'J1540 (RETURN) (START/RETURN)'.
- Move the screen down by storing a $90 in location $6A and doing a JSR $F3F6: 'A 6A 90 (RETURN)','J F3F6 (RETURN) (START/RETURN)'
- Read BASIC back into memory with 'R1 A000 40 (RETURN)'.
- Find the initialization address by looking at location $BFFE. Since that is $BFF9, execute 'J BFF9 (RETURN) (START/RETURN)'.
- Find the start address by looking at location $BFFA. Since that is $A000, execute 'J A000 (RETURN) (START/RETURN)'.

BASIC will now come up running. Now we want to create a binary load file to simulate the last 4 steps:

- Type 'DOS' to get to the DOS menu.
- Use the 'K' command to save BASIC as a binary load file giving it the start address of A000 and the end address of BFFF.
- Pop into OMNIMON and put it in linked mode. Read the first sector of the new file into $6000 (see top of page 7 if you don't know how to find the first sector of a file).
- Hold down RETURN until 'EOF' is printed out. You now have the last sector of the file in memory.
- Determine the last byte of that sector in use by looking at the byte count ($607F). Start adding the following bytes at location $6000 + byte count (we are appending to the file):6A 00 6A 00 90 E2 02 E3 02 F6 F3 00 98 08 98 20 06 98 6C FA BF 6C FE BF E0 02 E1 02 00 98.
- Increase the byte count ($607F) by $1E and write that sector back out to the disk with 'W (RETURN)'.

Here is an explanation of these load vectors: The first 11 bytes move the screen down and the rest load a little routine into $9800 to initialize and start the cartridge. Disassemble them to see how. Except for the booby traps, you should be able to easily extend this technique to 16K cartridges. However, some cartridges assume that memory is clear, so you can append the following load vectors: 09 98 23 98 A0 00 A9 07 85 D5 A9 00 85 D4 A9 00 91 D4 E6 D4 D0 F8 E6 D5 A9 30 C5 D5 D0 F0 E2 02 E3 02 09 98 60. This will clear out DOS before starting the cartridge.

Ramdisk Hardware Modification

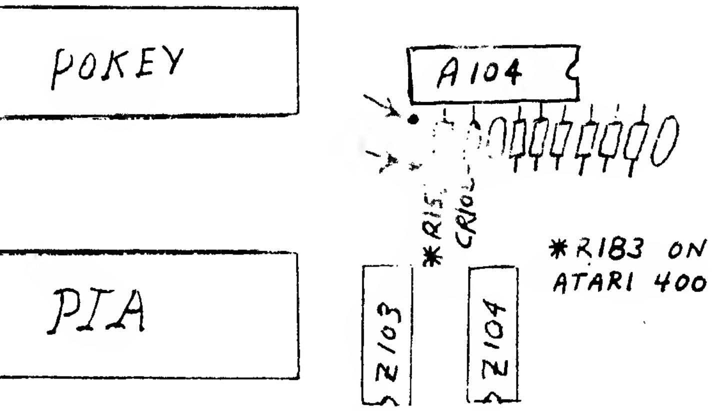
A very useful modification can be made to your Ramdisk board to make it much better behaved. It will save you from having to flip the switch on the Ramdisk in order to run software which loads into the $FC0-$FFF range. As it stands, writing to this address range will cause Ramdisk banks to be switched in in place of user memory. This usually causes the program to crash. This mod disables the $FC0-$FFF range and doubles the other select range from $CFC0-$CFFF to $CF80-$CFFF, which should cause no problem. If you do this mod carefully it will probably not affect the warranty but it is best to check with AXLON to be safe. In the past they have recommended it.

1) Locate pin 18 on the card edge of the RAM board in the front RAM slot (the slot just behind the OS board). It does not matter what type of RAM board this is (16K or 32K). Follow the etch back to a convenient place to solder (perhaps the pin of an IC) and solder one end of a 6" wire to this spot. On an ATARI 16K board this would be Z501 pin 1.
2) Locate the 74LS133 IC on the Ramdisk. Solder the other end of the wire to pin 15 of this IC. Referring to the diagram below, make the indicated cut on the underside of the Ramdisk board and the mod is complete.

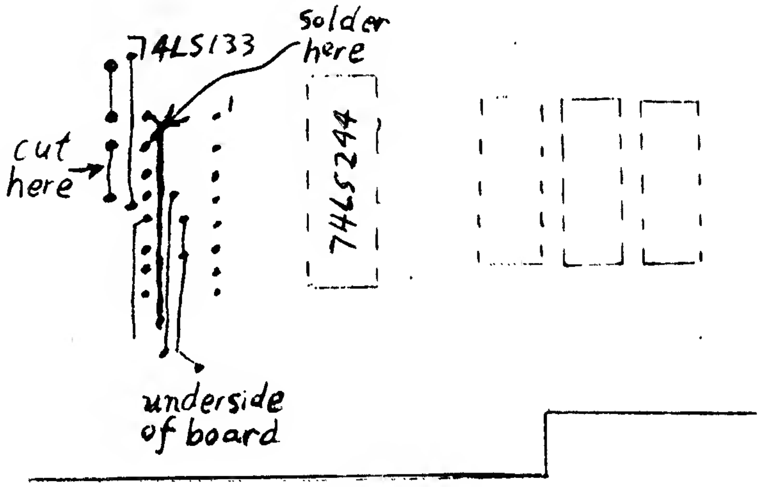
Coldstart Switch

This switch connects the RESET button directly to the Reset pin on the 6502, allowing you to do a coldstart without cycling power. This is especially useful in conjunction with the Ramdisk because its contents are preserved as long as you don't cycle power. (This is not true under the original Memory Management System supplied by AXLON.) It is also possible to recover from system lockup by pushing the coldstart switch and popping into OMNIMONL with SELECT/RESET. From that point you can many times restart the program by hitting SYSTEM/RESET (e.g., BASIC).

Installation is accomplished by disassembling the computer and locating the pads on the motherboard as indicated in the drawing for the 800. On a 400 the pads are located in the back right hand corner between R179 and CR103. A spring loaded switch (cheap Radio Shack pushbutton is fine) should be put in series with a 47 Ohm 1/4 watt resistor between the two pads. Mount the switch just to the left of the cartridge hatch.



800 Reset mod



Ramdisk Mod

OMNIMON Enhancements

When the OMNIMON unit is purchased it comes with the standard version of the OMNIMON ROM (the chip with the OMNIMON! label) installed. The many fine features of the standard version are satisfactory for the needs of many users. However, you may find a need for additional tools as you become more advanced or as you expand your system (AXLON Ramdisk, Happy Enhancement, Bit3 80 Column, etc.). The various enhanced versions of OMNIMON are designed to meet your needs.

The different Versions will be described below along with the price of each. To order, send a check or MO to:

CDY Consulting
421 Hanbee
Richardson, TX 75080

If you order your OMNIMON board directly from CDY (214-235-2146), you may order one or more of the enhancements at the same time at a $5.00 discount. If you already have a board, get a friend to order one so that you both can get a discouunt on the enhancements. Your check, money order, Visa, Master Card or COD are accepted.

Standard Version ($99.95): This is the PC board everyone must have to get started. It has a HELP command which is useful for beginning OMNIMON users because it lists all the commands and parameters. The enhanced versions replace this command with other useful features.

Advanced Version A ($15.00): This version has features which most users will find useful: Hex Conversion, Verify to compare 2 blocks of memory, Happy Upload/Download to talk to the RAM buffers in a Happy drive, support for the RESET mod which allows you to recover from system lockup, and printer I/O redirection to allow you to echo all OMNIMON interactions to, say, a disk file.

Ramdisk Version R ($25.00): This (or the L version) is a must for all AXLON Ramdisk owners! It allows you to use your Ramdisk under many environments which up to now were not compatible with this product. This includes most DOS's (Atari, OSA+, MYDOS, etc.) and many games and word processors. The contents of Ramdisk are preserved under coldstart which, in conjunction with the lockup recovery, makes your programs in Ramdisk much safer. You can even boot from Ramdisk! A simple hardware mod is described which makes the Ramdisk compatible with all software (no need to ever turn it off).

Banked Version L ($25.00): This version was designed for those of you who do not need the debugging commands of OMNIMON so much as some powerful disk I/O facilities. Among these facilities you will find the Ramdisk support described above and a binary load command which will load ANY binary load file without DOS and doubles as a disk directory command. Other commands unique to this version include move memory, programmability (it will remember a sequence of commands), and hexadecimal arithmetic (+,-,*,/). Also, it is user extendible, i.e., there are certain fixed entry points into OMNIMON through which external software can access many of the most useful routines in the monitor. The documentation explains the use and calling mechanism of each routine. But what if you are unwilling to give up the debugging commands for all of this? Not to worry. The U version is made to complement the L version. Read on.

Banked Version U ($15.00): The debugging commands left out of the L version are present in the U version with the addition of a couple of new ones. U and L were designed to work together. In fact, U should not be used without L. But how do you use both 4K programs when there is only one 4K socket provided? If you order U and L together they will come in a single 8K chip with a switch attached. You simply mount the switch and then you are free to toggle back and forth between the lower and upper (L and U) banks. It will even prompt you when you try to use a command which is in the other bank. The two new commands are a mini-assembler and a relocate command for translating 6502 code to executable code anywhere in memory.

OMNIMON Version#/Feature Correspondence Matrix

Command	Standard	Advanced-A	Ramdisk-R	Banked-L	Banked-U
A:Alter Memory	*	*	*	*	*
B:Boot (Ram)disk	-	-	*	*	-
C:CPU Registers	*	*	*	*	*
D:Display Memory	*	*	*	*	*
E:Single Step	*	*	-	-	*
F:Fill Prgm Buffer	-	-	-	*	-
G:Bin Load / Dir	-	-	-	*	-
H:Hex Conversion	-	*	*	*	-
H:Hex Arithmetic	-	-	-	*	-
I:Install Ramdisk	-	-	*	*	-
J:Jump Subroutine	*	*	*	-	*
L:Drive Control	*	*	*	*	-
M:Move Mem Block	-	-	-	*	-
N:Reloc 6502 Code	-	-	-	-	*
O:Operate Prgm Buf	-	-	-	*	-
P:Printer Control	*	*	*	*	*
R:Read from Disk	*	*	*	*	-
S:Search Memory	*	*	*	*	-
T:Tgl Hex/Chr Mode	*	*	*	*	*
U:User's Command	-	-	-	*	-
V:Verify Memory	-	*	*	*	-
W:Write to Disk	*	*	*	*	-
X:Disassemble Mem	*	*	*	-	*
Y:Assemble to Mem	-	-	-	-	*
Z:Exit monitor	-	-	-	*	-
Lockup Recovery	-	*	*	*	-
Prtr I/O Redirect	-	*	*	*	*
Happy Support	-	*	*	*	-
Bit3 Support	-	*	*	*	*
Ramdisk Support	-	-	*	*	-

AXLON Ramdisk Support: 'I' and 'B' commands

These commands allow Ramdisk owners to take full advantage of the power and flexibility of this marvelous device. The resident Ramdisk handlers in OMNIMONL allow you to use your Ramdisk with any DOS which uses standard SIO calls ($E459 and $E453). Operation of the Ramdisk in conjunction with drives other than single density is possible if the DOS will support them (e.g., OSA+, MYDOS, etc.). In addition, you will find it possible to use the Ramdisk with other boot programs which require a lot of disk access (e.g., DBMSs, word processors, games, etc.). The general rule is that any program that will restart when you hit SYSTEM RESET (instead of rebooting) should be able to use the Ramdisk just like any other single density disk drive. It also makes things easier if the program has no disk copy protection.

The main command to support Ramdisk is 'I (drive#)'. This command installs the resident Ramdisk handlers into whatever software is currently in memory. It does so by searching all of memory for all references to $E459 and $E453 and replacing them with hooks into OMNIMON ($CFC8 and $CFCB respectively). In this way all SIO calls are intercepted and examined to see if the Ramdisk is being addressed. If it is, the special handlers take over. Else, the call is passed on to SIO.

Installation Technique #1

The basic technique for installing the Ramdisk handlers is to boot-up the software, pop into OMNIMONL with OPTION/RESET, use the 'I' command and then restart the program by holding down the START switch and typing RETURN. This is the same as doing a warmstart with a brief stopover in OMNIMONL. If hitting RESET causes th program to reboot (e.g., ATARI DOS 2.0S) then you may use SELECT/RESET to interrupt the program. If the program restarts when you exit OMNIMONL with START/RETURN, then everything is probably fine. If you are unable to restart the program without rebooting then another method can be used (see Installation Technique #2).

Let's take a typical example:

1) Be sure that your Ramdisk is enabled and boot up ATARI DOS 2.0S (or any of the many modified versions). Once the DOS menu appears, pop into OMNIMONL with SELECT/RESET.
2) Now type 'I(return)'. (If you do not specify a drive # after the 'I', drive #1 will be assumed.) Drive #'s equal to or greater than the Ramdisk drive # will be incremented by 1.
3) Return to the DOS menu by holding down the START switch and typing RETURN. Hit RETURN once again to get the menu back.
4) Format the Ramdisk with the I command of DOS.
5) Write DOS files to the Ramdisk with the H command of DOS.
6) Hit SYSTEM RESET. If you did the previous steps correctly, the DOS menu should appear very quickly since it will now boot out of the Ramdisk.

Now you can treat the Ramdisk just like any other single density drive in the system. If you wish to assign it a different drive #, pop into OMNIMONL and use the 'I' command again with the new drive #. Notice that once the 'I' command has been used, the 'R' and 'W' commands of OMNIMONL will also treat the Ramdisk just like another disk drive. Use the 'L(#)' command to address the different drives in the system.

Ramdisk installation can be accomplished from assembly language by storing the drive # in TIBNUM ($94) and doing a JSR INSNUM ($CF24). The following 11 bytes appended to the end of a binary load file will automatically install the Ramdisk handlers (where drv# = 1 to 4): 94 00 94 00 drv# E2 02 E3 02 24 CF. Appended to the end of DUP.SYS, these load vectors will take the place of installation technique #1 when you boot up DOS.

Installation Technique #2

This method will allow you to use Ramdisk with many boot programs which do not use DOS or have their own file management system. This method will work only if the program is on an unprotected disk.

1) Boot up a disk sector copying program. Install the Ramdisk as drive #1 using technique #1.
2) Duplicate the boot disk using the Ramdisk as the destination drive.
3) Pop into OMNIMONL again and select the Ramdisk with the 'L' command. (It is already selected if it is drive #1.)
4) Now we must install the Ramdisk handlers into the program on the Ramdisk. This is done by reading the program into memory, using the 'I' command and writing the program back out to disk. If the program takes the entire disk then the following sequence will work: R1 400 100,I,W1 400 100,R101 400 100,I,W101 400 100,R201 400 D0,I,W201 400 D0. This is not as much typing as it looks because of the screen editing features of OMNIMON.
5) Now type 'B(return)'. This command will boot off the selected drive but most of the time will work only on drive #1. It is especially useful for booting off the Ramdisk.

This method may not work with some programs because they have interrupt routines located in the address range of $4000 to $7FFF. Because Ramdisk uses this area of memory for its bank switching, you can see how an interrupt routine in this region would not work too well during Ramdisk I/O.

Once the program is in the Ramdisk, you can always reboot it with the 'B' command, even if you have run other programs since copying it up there. This is especially true if you do the simple hardware mod described next. But don't cycle power or the contents of Ramdisk will be lost. If you wish to do a coldstart, do a 'JE477 (return) START/RETURN' from OMNIMON or install a coldstart switch as indicated on the next page. By the way, the Ramdisk uses banks 1 to 7 while the user bank is bank 0.

OPTIONAL SWITCH FOR OMNIMON!*

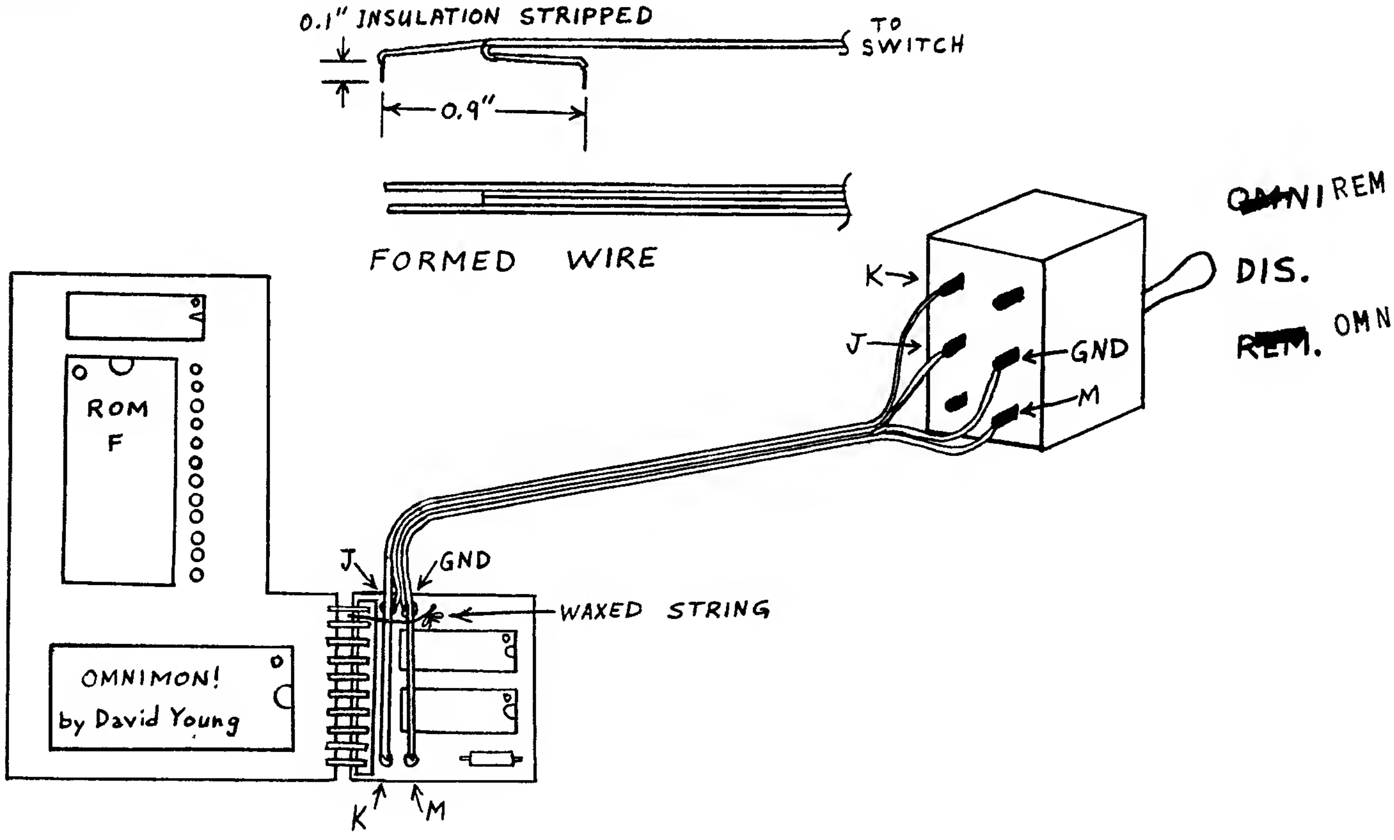
CAUTION: Make sure your OMNIMON!* board works in your system before installing this switch.

For the purpose of running software which is incompatible with a modified ATARI OS** or other hardware or software that does not want any memory in the $C000 address space a DPDT switch with center off (Radio Shack #275-620 or equal) may be added. A 12" to 14" length of four(4) conductor 26 gauge wire is enclosed with your OMNIMON! board. Solder one end of the wire to 4 of the 6 contacts on the DPDT-center off switch as shown below. The individual wires should seperate by pulling them apart but starting the seperation by snipping between the wires with small wire cutters helps. Form the other end of the wire as shown below. Remove the 1.0" jumper wire between the J and K sockets, save this wire incase you want to remove the switch later. Insert the wires on the formed end as shown below into the sockets labeled K, J, GND and M. Make sure the wires are fimly in the sockets and not shorting against anything else. Tie the wires to the board as shown below with small waxed string (waxed dental floss workes good).

The switch positions have the following meanings:
OMNI - OMNIMON!* resides at address $C000 with SELECT or OPTION/RESET interrupt active,
DIS. - OMNIMON!* resides at address $C000 with SELECT or OPTION/RESET interrupt disabled (Atari OS** is unmodified) and
REM. - address space $C000 is empty and Atari OS** is unmodified.

To have the Optional Switch added to your board,
return it with a check or money order for $15.00 to:
The Peipheral Connection, attn./ Bill Williams, (817)465-5964
2814 S. Cooper St., Suite 256, Arlington, Texas 76015
Above pricing is in U.S. dollars on a U.S. bank. Canadian orders add $5.00 and other foreign orders add $15.00 for postage and handling.

* trademark of CDY Consulting
** trademark of ATARI, Inc.



OMNIMON!* WARRANTY

The OMNIMON!* board is warrantied by CDY Consulting against defects in materials and manufacturing for a period of one(1) year from the date of purchase. This does not apply to hardware that has been misused, abused, modified (except for the optional switch addition if installed correctly), unauthorized repair, installed incorrectly or damaged in shipment.
This warranty is limited to repair or replacement of the OMNIMON!* board only.
If you suspect a board to be defective, describe the problem and return the board to the address below (not to the dealer you purchased it from) with the original OMNIMON!* ROM in the original packaging.
A registration card must be on file for warranty work to be performed.

- <> If the board is found to be defective it will be repaired and returned at no charge. Try the board BEFORE adding the optional switch.
- <> If the board is found to be defective due to factors other than defective materials or manufacturing the board will be repaired for a fee of $15.00 ($25.00 if physically damaged beyond repair).
- <> If the board is recieved in working condition the board will be returned for a handling fee of $5.00. Make sure the board has been installed properly before returning. EVERY board is tested and guaranteed working before leaving the factory.
- <> All the above prices include return C.O.D. UPS ground postage, subtract $2.00 for pre-payment and add $2.00 for UPS blue label.
- <> If in doubt, describe the problem and return the board and you will be notified by return postcard if there are any charges.

The above pricing is in U. S. dollars on a U. S. bank. Canadian orders add $5.00 and all other foreign orders add $15.00 for postage and handling.

Refer questions on OMNIMON!* to:
CDY Consulting, David Young (214)235-2146
421 Hanbee, Richardson, Texas 75080

For quickest repair send board with original OMNIMON!* ROM and packaging to:
The Peripheral Connection, Bill Williams (817)465-5964
2814 S. Cooper, Suite 256, Arlington, Texas 76015

* trademark of CDY Consulting

OMNIMON! INSTALLATION INSTRUCTIONS

*** OMNIMON! is a trademark of CDY Consulting.
*** ATARI and ATARI 400/800 are trademarks of ATARI, Inc.

CAUTION: Your ATARI 400/800 computer and the OMNIMON! board contain STATIC SENSITIVE electronic components. Use a sheet of aluminum foil as your work surface. Make sure your computer is unplugged. Always touch the aluminum foil with both hands before picking up electronic components. Read these instructions completely before installing the OMNIMON! board.

ATARI 800 (see drawing on back):

1) Remove the personality board from slot 1 of your 800. Remove the case from the board and lay the board on the aluminum foil work area. The case is no longer needed. It is also recommended that you remove the case from the RAM board in slot 2.
2) Remove ROM "F" from the board by inserting a small flat bladed screwdriver between ROM "F" and the ATARI socket. Pry ROM "F" out of the socket by prying first at the top of the chip and then at the bottom to slowly rock it out of the socket. Place ROM "F" on the aluminum foil work area.
3) For this step the OMNIMON! board should be left on the styrofoam packing to be sure the pins on the bottom of the OMNIMON! board are not bent. Insert ROM "F" into the ROM "F" socket provided on the OMNIMON! board. First align the pins on one side of the chip and then the other side until all pins are aligned to the center of the socket holes. Press ROM "F" into the socket evenly until the chip is seated all the way into the socket. Make sure all of the pins went in straight and none are bent.
4) Next, connect the wire on the OMNIMON! board from the hole labeled "H" to pin 20 of ROM "D". This may be performed by using either method "a" or "b".
   a) Solder the loose end of the wire to pin 20 of ROM "D" on the back side of the ATARI board.
   b) First remove ROM "D" from its socket in the same manner as ROM "F" in step 2 above. Insert the loose end of the wire into the socket at pin 20 of ROM "D". If the wire feels snug then re-insert ROM "D" into the ATARI socket in the same manner as ROM "F" in step 3 above. Test the snugness of the wire. If it pulls out easily, use method "a" above.
5) Next, insert the OMNIMON! board into ROM "F" socket on the ATARI board. If the ROM "F" socket pins on your ATARI board are sprung the OMNIMON! board may not fit snugly enough to stay in place under the normal vibration of moving the computer around. In this case, use the enclosed waxed string to secure the OMNIMON! board to the ATARI ROM "F" socket. Route the waxed string under the ATARI ROM "F" socket from top to bottom. Tie the string around the board as shown in the drawing.
6) Re-install the personality card into slot 1 of your 800.
7) Power up the computer as you normally would. If the screen is blank or otherwise abnormal, re-check your installation. Especially check for bent or misaligned pins. All the OMNIMON! boards are tested before leaving the factory. If you suspect the fault is with the OMNIMON! board, please refer to the LIMITED WARRANTY section of the OMNIMON! USER'S MANUAL.

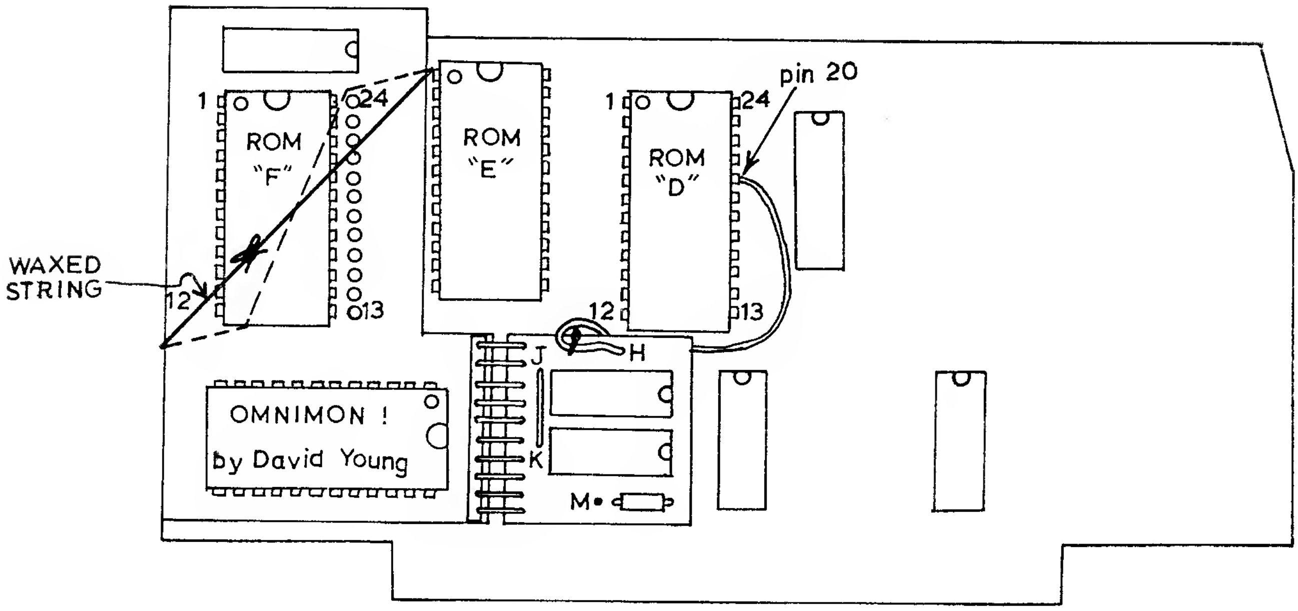
ATARI 400 (see drawing on back):

Installing the OMNIMON! board into the ATARI 400 is the same as for the ATARI 800 except for the following steps:

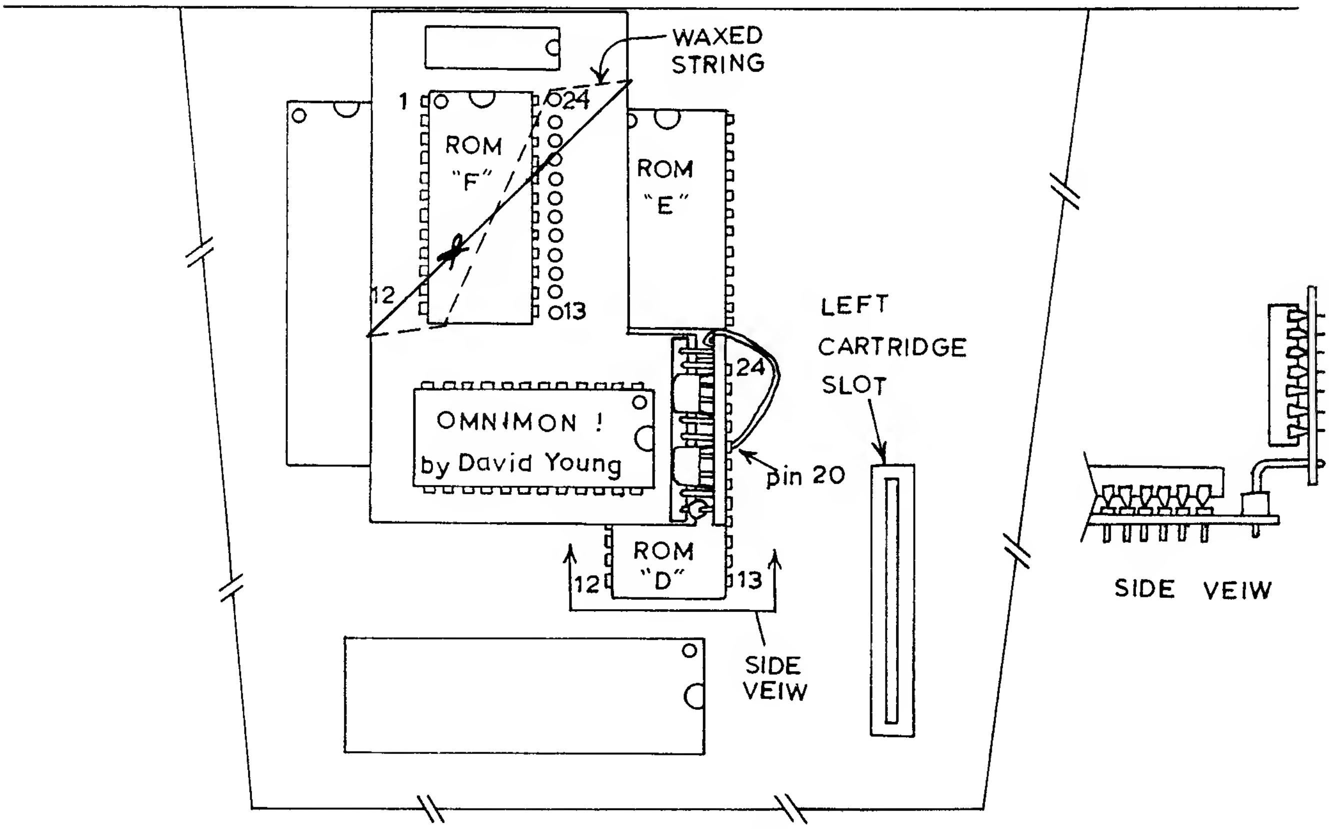
The extra socket is used as a spacer between the ROM "F" socket and the OMNIMON! board.

1) Bend the OMNIMON! board at a 90 degree angle as shown in the SIDE VIEW. Remove the ATARI 400 mother board. It is recommended that you have the help of someone with prior experience in disassembling the ATARI 400.
6) Re-install the ATARI 400 mother board.

OMNIMON! INSTALLATION DRAWINGS



ATARI* 800



ATARI* 400

HARDWARE BY BILL WILLIAMS

* TRADEMARKS OF ATARI, INC.